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UNITED STATES DEPARTMENT OF AGRICULTURE

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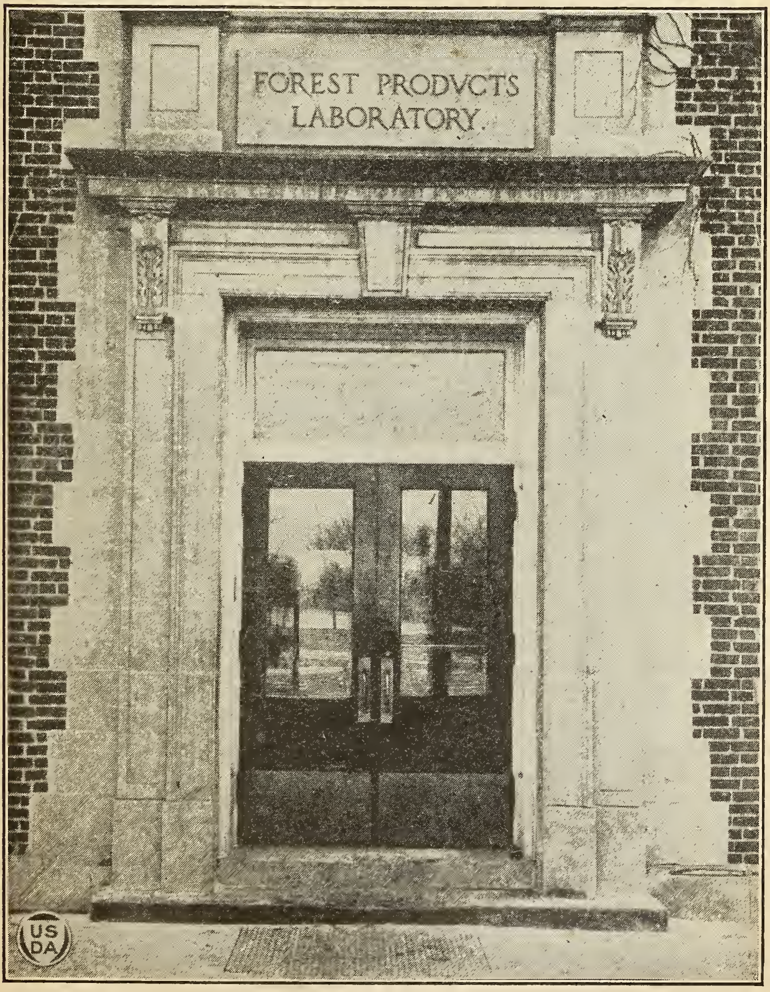
DEMONSTRATION COURSES IN KILN DRYING, BOXING AND CRATING, GLUING OF WOOD, WOOD PROPERTIES AND USES.

Prepared by the Forest Products Laboratory, Forest Service.



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FOREST PRODUCTS LABORATORY.

To promote the best and most economical use of the products of our forests and thus help to perpetuate the forests themselves, the Forest Service of the United States Department of Agriculture maintains, at Madison, Wis., in cooperation with the University of Wisconsin, the Forest Products Laboratory.

Although primarily an institution for research, the Forest Products Laboratory has also as one of its primary functions the task of getting into use the knowledge and the processes it discovers. It has gathered much useful information on the properties of wood and on the manufacture and use of wood products. A large part of the field for the practical application of this knowledge is in the industries. The economical use of wood is of large importance not only to the Nation as a whole, threatened with the consequences of forest depletion, but to the industries, which will benefit by improved practices and by the saving of raw material.

The laboratory publishes the results of its research in bulletins, technical notes, and trade journals. It also employs correspondence and personal contact. In still other instances it has found its greatest success in personal instruction by which manufacturers, trade specialists, salesmen, and consumers meet at the laboratory for demonstrations, tests, lectures, study, and discussion of individual problems. These demonstration courses are given in the kiln drying of lumber, boxing and crating, gluing of wood, and wood properties and uses. The instruction in these subjects aims to give not only basic knowledge, but its practical application to everyday problems. That these demonstration courses are a feasible means for such practical application is evidenced by letters from many men who have attended the courses, and from the companies they represent, telling of problems solved by the knowledge gained at the laboratory.

Details of the courses are given in the following pages. As each course fully occupies the time of the person enrolled, it is impracticable to take more than one course at a time. Stress is laid on the practical aspects of the subjects, so that no one need hesitate to enroll because of a lack of formal technical training.

THE KILN DRYING OF LUMBER.

The demonstration course in the kiln drying of lumber is intended for factory and sawmill executives, foremen, kiln operators, and other employees handling lumber or wood products. The instruction is not confined to any particular type of kiln or kind of lumber, but rather to the broad principles underlying success in seasoning wood.

Besides several kilns which are continually in operation and used in instruction, the laboratory has a convertible demonstration kiln which can be operated under either natural or forced circulation, thus simulating various types of commercial kilns, and by contrast bringing out some very important points in regard to the circulation of air. An unusual feature of this kiln is that it is equipped to provide for reversible circulation, which aids very materially in accomplishing rapid and uniform drying.

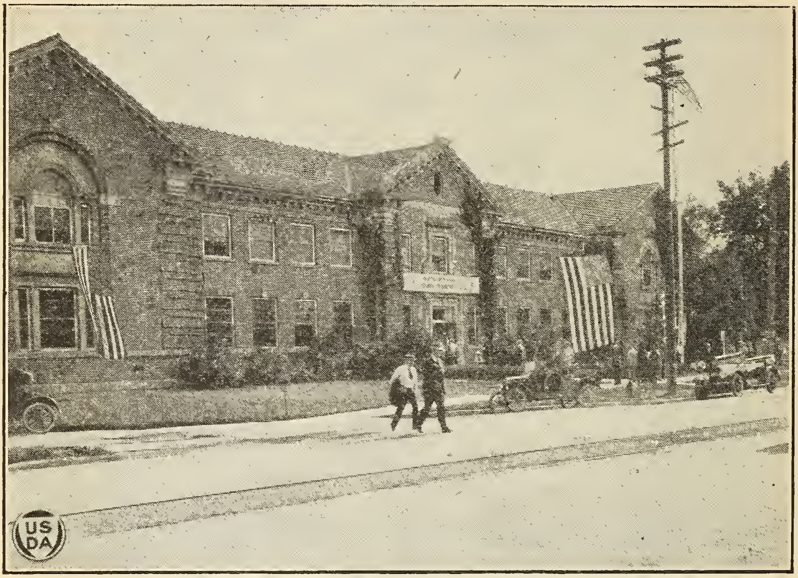
In order to make sure that the methods of kiln operation are thoroughly understood, a kiln charge of lumber is dried during the course, and the men observe the tests of sample boards, which are examined from time to time to see if the lumber is drying properly.

A representative group of men attending demonstration courses in kiln-drying, boxing and crating, gluing, and wood properties and uses.

WHAT THE COURSE COVERS.

Building and equipping the kiln.—Principles of kiln design; adaptability of different types of kilns for different species of wood; remodeling of kilns; desirable equipment; methods of installing heating system; temperature recorders and controllers.

Operating the kiln.—Calibration of instruments; methods of testing kilns; selection and placing of sample boards; end coatings; measuring drying rates; testing lumber; safe drying schedules for all commercial woods.



Main Building, Forest Products Laboratory.

> *Heat in the kiln.*—Correct temperatures to use; effect of degree of heat on transfusion of moisture through wood, on capacity of air for picking up moisture, and on plasticity of wood.
>
> *Humidity in the kiln.*—Importance of humidity in drying lumber; how the humidity is maintained; how determined; correct humidities to use.
>
> *Circulation in the kiln.*—Circulation necessary to secure uniform and rapid drying; how to secure circulation; how to test for circulation.
>
> *Steaming and conditioning.*—Steaming to secure rapid initial heating; steaming to kill mold; conditioning to relieve casehardening and to prevent checking and honeycombing.
>
> *Demonstration kiln run.*—Observations on a load of lumber dried in one of the laboratory kilns during the course; use of kiln samples; moisture tests; casehardening tests.

A study of wood.—This is of extreme importance in determining the best kiln drying practice.

> *Structure and composition of wood.*—Kinds of cells in wood; advantages of wood because of cellular structure; how a tree grows; formation of annual rings; springwood and summerwood;

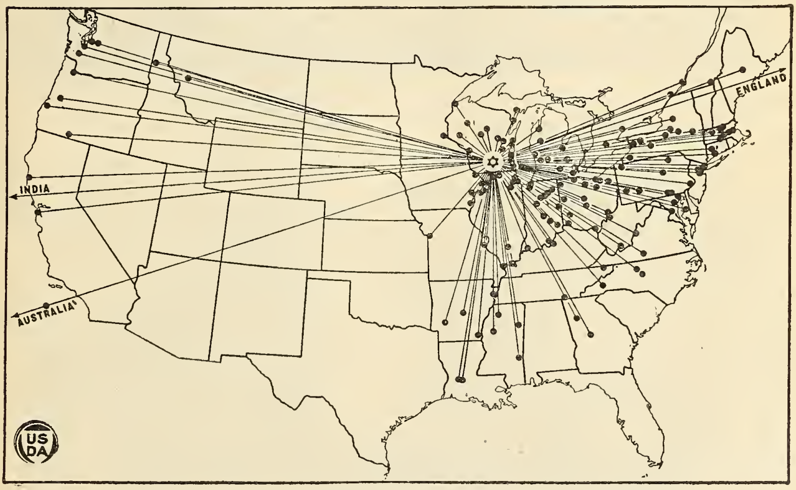
plain-sawed versus quarter-sawed lumber; heartwood versus sapwood.

Moisture content of wood.—A simple method of determining the percentage of moisture in wood; proper moisture content for various uses; variation of moisture in wood with changes in atmospheric humidity; how to store lumber and other wood products; advantages of specifying moisture content as well as grade in buying seasoned lumber; retarding changes in moisture content by using protective coatings; relative advantages of paints, oils, varnishes, shellac, etc., for this purpose.

Shrinking and swelling of wood.—Cause of shrinking and swelling; effect of density and moisture content on shrinkage; percentage of shrinkage of various woods; effect of different methods of drying and other treatments on the shrinkage of woods; how shrinking and swelling may be reduced to a minimum.

Identification of woods.—Characteristics of common woods which help to identify them.

Defects in drying and how to prevent them.—Casehardening; what it is; what causes it; objections to using casehardened lumber; test for casehardening; how casehardening may be avoided or overcome; cause and prevention of checking and honeycombing; cause and prevention of collapse; cause of cupping, warping and bowing, and how these may be reduced in seasoning.



Geographical distribution of firms represented at courses in kiln-drying.

Effect of kiln drying on the strength of wood.—High temperatures may reduce the strength of wood; effect of kiln temperatures on different properties of wood; temperatures permissible for different species of wood.

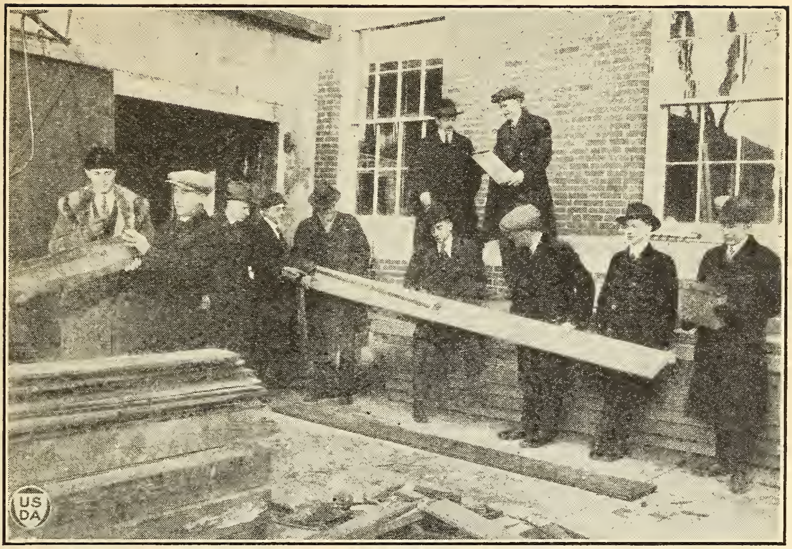
Air seasoning of lumber.—Purposes; need for better practice; proper methods of piling; time required; defects which may result from air seasoning.

Decay and durability of wood.—Cause of decay; how it spreads; seriousness of decay; methods of checking spread of decay; preservative treatments; natural durability of common species.

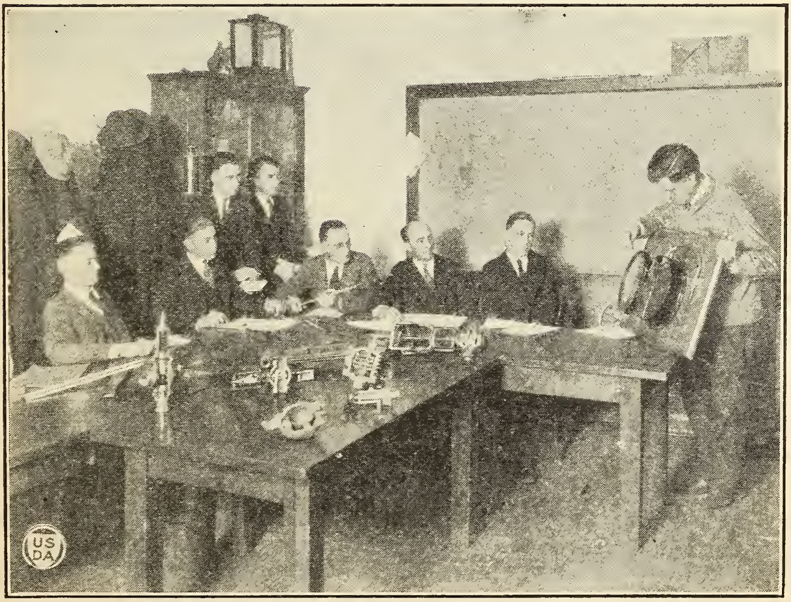
Glues.—Kinds of glues on the market; how made; for what purpose each is most suitable; plywood and laminated construction; possibilities of gluing together small pieces to form large members.

FIRMS WHICH HAVE BEEN REPRESENTED AT COURSES IN KILN DRYING.

- Automobiles:
  - Buick Motor Co., Flint, Mich.
  - Ford Motor Co., Detroit, Mich.
  - Maxwell Motor Corporation, Dayton, Ohio.
  - Nordyke & Marmon Co., Indianapolis, Ind.
  - Packard Motor Car Co., Detroit, Mich.
  - Willys-Overland Co., Toledo, Ohio.
  - Yellow Cab Manufacturing Co., Chicago, Ill.
- Auto bodies:
  - H. & M. Body Corporation, Racine, Wis.
  - Hayes-Ionia Co., Ionia, Mich.
  - Racine Manufacturing Co., Racine, Wis.
  - Seaman Body Corporation, Milwaukee, Wis.
  - Sedan Body Co., Union City, Ind.
  - Union City Body Co., Union City, Ind.
- Beehives:
  - A. I. Root Co., Medina, Ohio.
- Boxes:
  - Columbia Box Co., St. Louis, Mo.
  - Kansas City Shook & Manufacturing Co., Wilson, Ark.
  - Mengel Co., Louisville, Ky.
  - Mengel Co., Winston-Salem, N. C.
  - New England Box Co., Greenfield, Mass.
- Brick:
  - Cherokee Brick Co., Macon, Ga.
- Cabinets:
  - Bryan Show Case Co., Bryan, Ohio.
  - Columbus Show Case Co., Columbus, Ohio.
  - Gamble Bros., Louisville, Ky.
  - Grand Rapids Show Case Co. Grand Rapids, Mich.
  - Harwood Products Co., Neenah, Wis.
  - Jamestown Panel Co. (Inc.) Jamestown, N. Y.
  - McDougall Co., Frankfort, Ind.
  - Mengel Co., Louisville, Ky.
  - Geo. W. Smith & Co. (Inc.) Philadelphia, Pa.
  - Wasmuth-Endicott Co., Andrews, Ind.
- Caskets:
  - National Casket Co., Asheville, N. C.
  - National Casket Co., Pittsburgh, Pa.
  - North St. Paul Casket Co., North St. Paul, Minn.
  - Geo. H. Sherwood & Son, Philadelphia, Pa.
- Cedar chests:
  - Casewell-Runyan Co., Huntington, Ind.
- Cedar chests—Continued.
  - Ferguson Bros. Manufacturing Co., Hoboken, N. J.
  - Ed Roos Co., Forest Park, Ill.
  - Standard Red Cedar Chest Co., Altavista, Va.
  - West Branch Novelty Co., Milton, Pa.
- Chairs:
  - American Seating Co., Grand Rapids, Mich.
  - American Seating Co., Manitowoc, Wis.
  - S. Bent & Bros. (Inc.), Gardner, Mass.
  - Buckeye Chair Co., Ravenna, Ohio.
  - Crocker Chair Co., Sheboygan, Wis.
  - Delaware Chair Co., Delaware, Ohio.
  - W. H. Gunlocke Chair Co., Wayland, N. Y.
  - Frank S. Harden Co., McConnellsville, N. Y.
  - Johnson Chair Co., Chicago, Ill.
  - Ladysmith Chair & Furniture Co., Ladysmith, Wis.
  - Marble & Shattuck Chair Co., Cleveland, Ohio.
  - Marietta Chair Co., Marietta, Ohio.
  - Milwaukee Chair Co., Milwaukee, Wis.
  - Parkersburg Chair Co., Parkersburg, W. Va.
  - Peru Chair Works, Peru, Ind.
  - S. K. Pierce & Son Co., Gardner, Mass.
  - Phoenix Chair Co., Sheboygan, Wis.
  - Standard Chair Co., Union City, Pa.
  - Taylor Chair Co., Bedford, Ohio.
  - W. F. Whitney Co., South Ashburnham, Mass.
  - Wisconsin Chair Co., Port Washington, Wis.
- Clocks: Seth Thomas Clock Co., Thomaston, Conn.
- Cooperage:
  - American Steel & Wire Co., Cleveland, Ohio.
  - Greif Bros. Cooperage Co., Cleveland, Ohio.
  - Hardwood Package Co., Philadelphia, Pa.
  - Western Cooperage Co., Portland, Oreg.
  - E. L. Young Heading Co., Aberdeen, Miss.
- Drying apparatus:
  - American Blower Co., Detroit, Mich.
  - Carrier Engineering Corporation, Newark, N. J.
  - Standard Dry Kiln Co., Indianapolis, Ind.
  - Welch Dry Kiln Engineering Co., Kansas Citn, Mo.



Demonstration kiln runs with accompanying tests of sample boards are part of the kiln-drying course.



A thorough knowledge of temperature and humidity control apparatus is essential to a good kiln operator.

- Electrical goods:
    - General Electric Co., Schenectady, N. Y.
    - Western Electric Co., Chicago, Ill.
- Farm implements:
    - Moline Plow Co., Moline, Ill.
    - Massey-Harris Harvester Co. (Inc.) Batavia, N. Y.
- Fixtures:
    - Albert Pick & Co., Chicago, Ill.
    - Van Duyne-Moran, St. Paul, Minn.
- Freight cars:
    - American Car & Foundry Co., Chicago, Ill.
    - Mount Vernon Car Manufacturing Co., Mount Vernon, Ill.
- Furniture:
    - Aude Furniture Co., St. Louis, Mo.
    - Bagby Furniture Co., Baltimore, Md.
    - Bailey Table Co., Jamestown, N. Y.
    - Beach Furniture (Ltd.), Cornwall, Canada.
    - Berkey & Gay Furniture Co., Grand Rapids, Mich.
    - Chicago Mill & Lumber Co., Cairo, Ill.
    - Davis-Birely Table Co., Shelbyville, Ind.
    - P. Derby & Co. (Inc.), Gardner, Mass.
    - Easton Furniture Manufacturing Co., Easton, Md.
    - J. O. Frost's Sons, Towanda, Pa.
    - Greilick Manufacturing Co., Traverse City, Mich.
    - Haberer Furniture Co., Loweville, N. Y.
    - Hillenbrand Co., Batesville, Ind.
    - Jamestown Table Co., Jamestown, N. Y.
    - Johnson Furniture Co., Grand Rapids, Mich.
    - Karges Furniture Co., Evansville, Ind.
    - S. Karpen & Bros., Michigan City, Ind.
    - Kroehler Manufacturing Co., Naperville, Ill.
    - La Crosse Cooperage Co., La Crosse, Wis.
    - Long Furniture Co., Hanover, Pa.
    - Thomas Madden, Son & Co., Indianapolis, Ind.
    - Marsh Furniture Co., High Point, N. C.
    - Mersman Bros. Brandts Co. (Inc.) Celina, Ohio.
    - A. C. Norquist Co., Jamestown, N. Y.
    - Northfield Co., Sheboygan, Wis.
    - Reliable Furniture Manufacturing Co., Baltimore, Md.
    - Sieling Furniture Co. (Inc.), Railroad, Pa.
    - St. Johns Table Co., Cadillac, Mich.
    - St. Paul Table Co., North St. Paul, Minn.
    - L. & J. G. Stickley (Inc.), Fayetteville, N. Y.
- Furniture—Continued.
    - Tennessee Furniture Corporation, Chattanooga, Tenn.
    - Webster Manufacturing Co., Superior, Wis.
    - John Widdicomb Co., Grand Rapids, Mich.
    - Windsor Furniture Co., Chicago, Ill.
- Golf clubs: Kroydon Co., Newark, N. J.
- Instruments: Keuffel & Esser Co., Hoboken, N. J.
- Insulation: Flaxlinum Insulating Co., St. Paul, Minn.
- Lumber:
    - Richard P. Baer & Co., Baltimore, Md.
    - Booth-Kelly Lumber Co., Eugene, Oreg.
    - Bryant Lumber Co., Seattle, Wash.
    - Buehner Lumber Co., North Bend, Oreg.
    - Caddo River Lumber Co., Rosboro, Ark.
    - Chicago Mill & Lumber Co., Cairo, Ill.
    - J. W. Darling Lumber Co., Cincinnati, Ohio.
    - DeForest & Hotchkiss Co., New Haven, Conn.
    - Eastern Railway & Lumber Co., Centralia, Wash.
    - Fearon Lumber & Veneer Co., Ironton, Ohio.
    - Forest Lumber Co., Oakdale, La.
    - Freehold Lumber Co., Hot Springs, Va.
    - Industrial Lumber Co., Elizabeth, La.
    - Kraetzer-Cured Lumber Co., Greenwood, Miss.
    - Long-Bell Lumber Co., Quitman, Miss.
    - Meadow River Lumber Co., Rainelle, W. Va.
    - Modoc Lumber Co., Chiloquin, Oreg.
    - W. M. Ritter Lumber Co., Columbus, Ohio.
    - Snoqualmie Falls Lumber Co., Snoqualmie Falls, Wash.
    - Union Lumber Co., Fort Bragg, Calif.
    - Weyerhaeuser Lumber Co., Tacoma, Wash.
    - Winton Lumber Co., Gibbs, Idaho.
- Moldings:
    - Indiana Molding & Frame Co., Laporte, Ind.
    - F. Zimmerman Co., Cleveland, Ohio.
- Office equipment:
    - Commercial Furniture Co., Chicago, Ill.
    - Cutler Desk Co., Buffalo, N. Y.
    - Hamilton Manufacturing Co., Two Rivers, Wis.
    - Leopold Desk Co., Burlington, Iowa.
    - Library Bureau, Ilion, N. Y.
    - Macey Co., Grand Rapids, Mich.
    - Weis Manufacturing Co., Monroe, Mich.

Phonographs:
- Brunswick-Balke-Collender Co., Dubuque, Iowa.
- Brunswick-Balke-Collender Co., Muskegon, Mich.
- Thos. A. Edison (Inc.), Orange, N. J.
- Herzog Art Furniture Co., Saginaw, Mich.
- Modernola Co. (Inc.), Johnstown, Pa.
- Superior Cabinet Co., Muskegon, Mich.
- Wisconsin Cabinet & Panel Co., New London, Wis.

Pianos:
- Baldwin Co., Cincinnati, Ohio.
- A. B. Chase Piano Co. (Inc.), Norwalk, Ohio.
- Chase-Hackley Piano Co., Muskegon, Mich.
- Haddorff Piano Co., Rockford, Ill.
- Strauch Bros. (Inc.), New York, N.Y.
- Thomas Organ & Piano Co., Woodstock, Canada.
- Weber Piano Co., Worcester, Mass.

Piano actions:
- Standard Pneumatic Action Co., New York, N. Y.
- Thayer Action Co., Rockford, Ill.

Planing-mill products:
- American Hardwood Flooring Co., Chicago, Ill.
- Bristol Door & Lumber Co., Bristol, Tenn.
- E. L. Bruce Co., Little Rock, Ark.
- Carrier Lumber & Manufacturing Co., Sardis, Miss.
- Carr, Ryder & Adams Co., Dubuque, Iowa.
- Curtis Bros. & Co., Clinton, Iowa.
- Curtis & Yale Co., Wausau, Wis.
- Huttig Manufacturing Co., Muscatine, Iowa.
- Jerome Hardwood Lumber Co., Jerome, Ark.
- Martin-Barriss Co., Cleveland, Ohio.
- Metropolis Bending Co., Metropolis, Ill.
- Moore & Galloway Lumber Co., Fond du Lac, Wis.
- Phoenix Planing Mill Co., Atlanta, Ga.
- Rowland & Buck, Port Deposit, Md.
- Segelke & Kohlhaus Manufacturing Co., La Crosse, Wis.
- Alfred Struck Co., Louisville, Ky.

Planing-mill products—Continued.
- J. W. Wells Lumber Co., Menominee, Mich.
- Willingham-Tift Lumber Co., Atlanta, Ga.
- Wood-Mosaic Co. (Inc.), New Albany, Ind.

Plumbers' supplies: Van Arnam Manufacturing Co., Fort Wayne, Ind.

Public institutions:
- Imperial College of Science, London, England.
- Queensland Government, Australia.
- Stout Institute, Menominee, Wis.
- University of Toronto, Toronto, Canada.
- U. S. Forest Service, Missoula, Mont.
- U. S. Forest Service, San Francisco, Calif.
- U. S. Forest Service, Madison, Wis.
- U. S. Forest Service, Washington, D. C.

Refrigerators:
- Grand Rapids Refrigerator Co., Grand Rapids, Mich.
- Illinois Refrigerator Co., Morrison, Ill.

Shoe lasts: United Last Co. (Ltd.), Montreal, Canada.

Spools and shuttles:
- American Thread Co., Milo, Me.
- Litchfield Shuttle Co., Southbridge, Mass.

Tags: Dennison Manufacturing Co., Framingham, Mass.

Vehicles:
- John Deere Wagon Works, Moline, Ill.
- Hercules Buggy Co., Evansville, Ind.
- Rock Island Arsenal, Rock Island, Ill.

Wheels:
- Hayes Wheel Co., Jackson, Mich.
- Kelsey Wheel Co. (Inc.), Detroit, Mich.

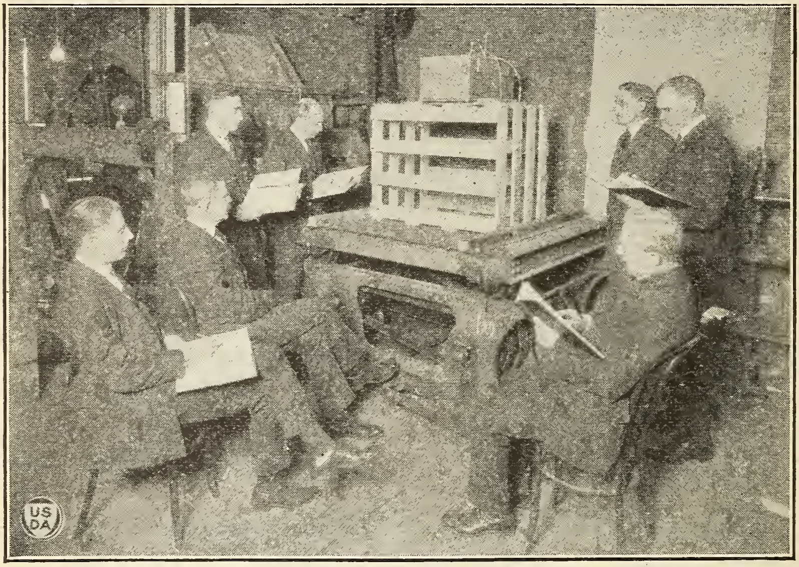
Individuals:
- S. S. Aiyar, Mysore State, India.
- Harold R. Bjerke, Boston, Mass.
- C. Gerald Clear, Waterville, Canada.
- E. C. Dickerson, Marshfield, Wis.
- Howard Eddy, Evanston, Ill.
- Russell E. Hetrick, Gladstone, Mich.
- William R. Kenney, Marshfield, Wis.
- H. E. Payne, St. Paul, Minn.

BOXING AND CRATING.

The demonstration course in boxing and crating is planned to be of assistance to anyone engaged in the manufacture or sale of shipping containers, and to anyone in charge of the selection and use of containers for the shipment of goods.

The Forest Products Laboratory is provided with extensive equipment for testing boxes and crates. Two hexagonal revolving drums, the larger 14 feet in diameter, give the boxes drops and knocks which simulate the actual stresses, shocks, and rough handling a package encounters in commercial service. The vibrating test machine reproduces the weaving action and shocks to which a shipping container is subjected by the swaying of a moving freight car and the starting and stopping of the train. Tests in the compression machine show the relative ability of different kinds of containers to resist crushing or distortion and are of particular value in studying the design of containers for the shipment of commodities requiring a rigid container. The drop test, in which boxes are dropped from various heights onto an iron block, provides a means of comparing their ability to resist sudden shock and distortion and brings out the characteristic weaknesses of the various styles of boxes.

All these tests are performed for the men attending the course. The men take the data, computing averages and drawing curves which bring out the good and bad points in the containers being studied. Frequent conferences are held at which points are discussed which can not be brought out by test.



The vibrating machine, or "shaker," gives a crate or a box treatment similar to what it receives in a moving freight car.

WHAT THE COURSE COVERS.

Characteristic weaknesses of different styles of wooden boxes.—Cleated-end boxes versus boxes without cleats; single-cleated boxes versus double-cleated boxes; boxes cleated on the inside; lock-corner boxes; ends fastened with corrugated fasteners; butt joints versus matched joints.

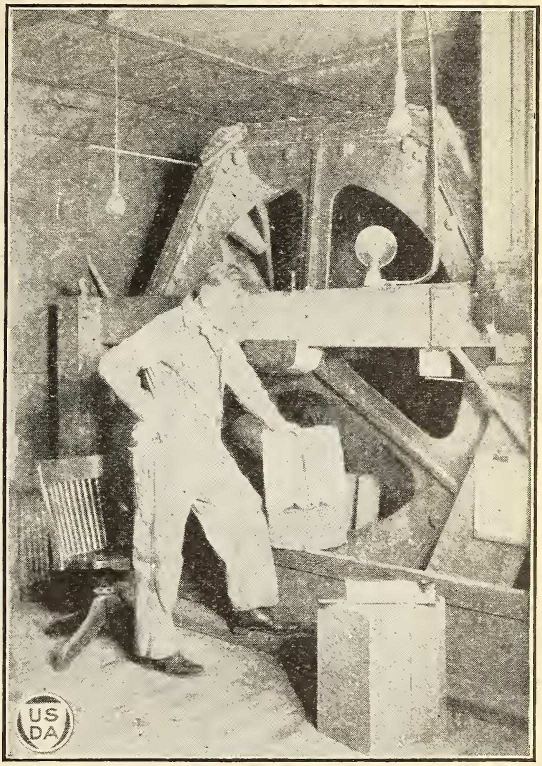
Nailing of boxes and crates.—Proper kind, size, and number of nails for boxes and crates constructed of softwoods and hardwoods; side nailing; effect of driving nails on a slant; proper diameter of nail, length of shank, and size of head.

Effect of varying the number of pieces in boxes.—Comparative strength of boxes having one, two, or more pieces in the ends, sides, top, and bottom; should one-piece material be used in ends, sides, top, or bottom of boxes? Merits of tongued and grooved material; value of Linderman joint.

Effect of using green lumber for boxes.—Comparative strength of boxes made of green and well-seasoned lumber; how storage effects the strength of boxes.

Strapping of wooden boxes.—Advantages and limitations of strapping; methods of application; nailed strapping versus nail-less strapping; annealed versus unannealed strapping; flat metal straps and wires; reduction in thickness of material permissible when strapping is used; nailing of boxes bound with strapping.

A study of box and crate woods.—Characteristics, distribution, and availability of different species; species best adapted for different types of containers; species best adapted for cold-storage boxes; species best adapted for export shipments.



The serviceability of corrugated and fiber boxes can be greatly increased by proper construction and reinforcement of the scores.

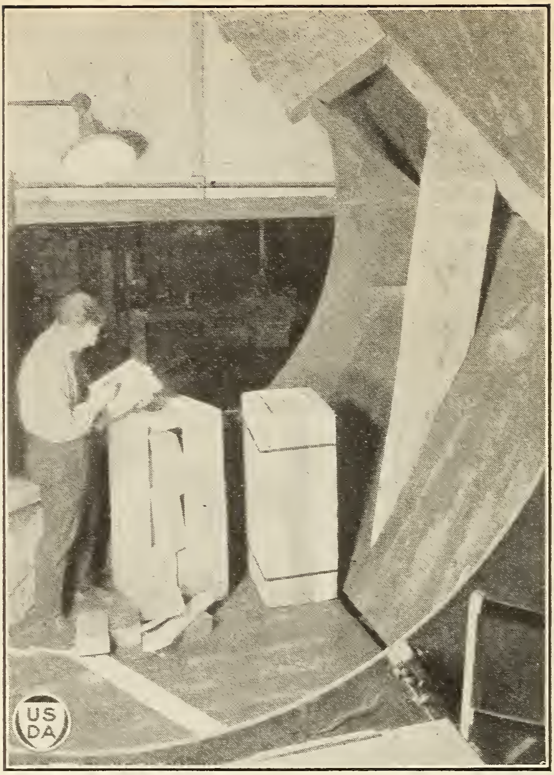
The structure and composition of wood.—Wood is composed of cells; advantages of wood because of celluar structure; how a tree grows; formation of annual rings; springwood and summerwood; plain-sawed versus quarter-sawed lumber; heartwood versus sapwood.

Physical and mechanical properties of box woods.—Importance of different strength properties of wood in box manufacture; comparative strengths of various box woods; relation of strength properties to specific gravity and moisture content; effect of knots and other defects on strength of boxes and crates.

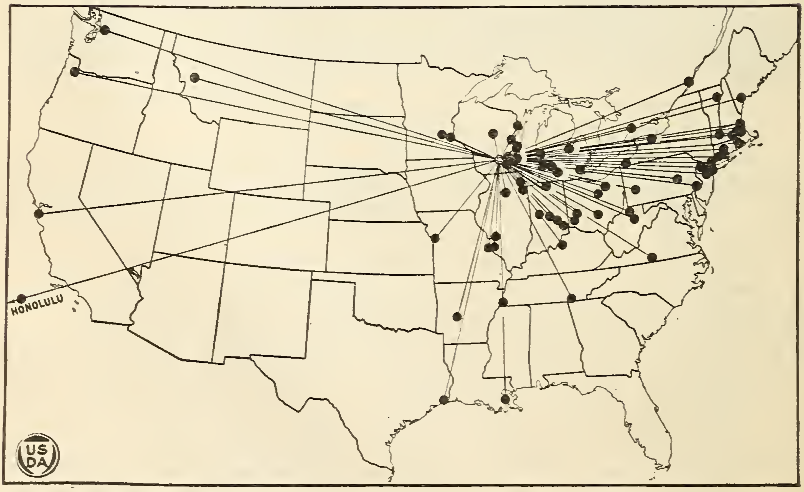
Hardwoods versus softwoods.—Thicknesses required for dense woods as compared with softwoods; nailing of dense woods; hardwoods for end construction of boxes; hardwood for crates.

Identification of woods used for boxes and crates.—Characteristics of various woods which help in identifying them.

Kiln drying of box lumber.—Advantages and limitations; methods commonly employed; necessity of properly regulating temperature and humidity in kilns; difficulties encountered in kiln drying; demonstrations of testing kiln-dried lumber.



Tests are made to demonstrate the value of metal strapping on boxes.



Geographical distribution of firms represented at courses in boxing and crating.

Characteristic weaknesses of different types of crates.—Advantages of the three-way corner; methods of bracing; diagonal bracing versus solid sheathing; relative size of frame members, skids, cross slats, and diagonal braces; metal fastenings.

Holding power of nails.—Relative holding power of barbed, cement-coated, and plain nails; effect of moisture content of wood on nail-holding power; nailing in side grain versus end grain; hardwoods versus softwoods.

Solid and corrugated fiber boxes.—Advantages and limitations of fiber boxes; effect of weather conditions; influence of direction of grain; advantages of different methods of sealing; methods of improving their serviceability.

Glues used in wooden and fiber boxes.—Kinds of glues in market; how made; for what purpose each is most suitable; plywood and laminated construction; possibilities in gluing together small pieces for large members.

Wire-bound boxes.—Characteristic weakness of 4-one wire-bound boxes; relation of end construction to thickness of sides, top, and bottom; thin ends reinforced with battens versus thick ends without battens; importance of nailing sides, top, and bottom to ends; rotary cut versus resawed lumber.

FIRMS WHICH HAVE BEEN REPRESENTED AT COURSES IN BOXING AND CRATING.

Automobiles:
  General Motors Corporation, Newark, N. J.
  Maxwell Motor Sales Corporation, Detroit, Mich.
Auto tops: Rex Manufacturing Co., Connersville, Ind.
Bee supplies: A. I. Root Co., Medina, Ohio.
Boxes:
  Anderson-Tully Co., Memphis, Tenn.
  Atwood & McManus Box Co., Chelsea, Mass.
  Baker Box Co., Worcester, Mass.
  Battle Creek Box Co., Battle Creek, Mich.
  J. C. Bulis Manufacturing Co., St. Louis, Mo.
  Chicago Mill & Lumber Co., Chicago, Ill.
  G. A. Crosman & Sons Co., Portland, Me.
  Embry Box Co., Louisville, Ky.
  Fairmont Box Co., Fairmont, W. Va.
  Firstbrook Bros. (Ltd.), Toronto, Canada.
  Forrester-Nace Box Co., Kansas City, Mo.
  4-One Box Makers' Association, Chicago, Ill.
  John Galbraith Co., Philadelphia, Pa.
  General Box Co., Chicago, Ill.
  General Box Co., Detroit, Mich.
  General Box Co., East St. Louis, Ill.
  Indianapolis Wirebound Box Co., Indianapolis, Ind.
  Kenfield-Lamoreaux Co., Chicago, Ill.
Boxes—Continued.
  F. J. Kress Box Co., Pittsburgh, Pa.
  G. B. Lewis Co., Watertown, Wis.
  Marinette & Menominee Box Co., Marinette, Wis.
  Meyer Thomas Co., Montreal, Canada.
  National Box Co., Chicago, Ill.
  New England Box Co., Greenfield, Mass.
  Pioneer Box Co., Crawfordsville, Ind.
  Rathborne, Hair & Ridgeway, Chicago, Ill.
  Republic Box Co., New Orleans, La.
Box machinery and supplies:
  Acme Steel Goods Co., Chicago, Ill.
  American Steel & Wire Co., Chicago, Ill.
  Wirebounds Corporation, New York, N. Y.
  4-One Box Machine Makers, Rockaway, N. J.
  Signode System (Inc.), Chicago, Ill.
Cameras:
  Eastman Kodak Co., Rochester, N. Y.
Canned and bottled goods:
  H. J. Heinz Co., Pittsburgh, Pa.
  Sears & Nichols Canning Co., Chillicothe, Ohio.
Cedar Chests: Standard Red Cedar Chest Co., Altavista, Va.
Cereal: Quaker Oats Co., Chicago, Ill.
Clocks: Western Clock Co., La Salle, Ill.
Clothing:
  Alfred, Decker & Cohn, Chicago, Ill.
  B. Kuppenheimer & Co., Chicago, Ill.
Confectionery: E. J. Brach & Sons, Chicago, Ill.

- Cooperage: Menasha Woodenware Co., Menasha, Wis.
- Electrical equipment:
  - Cutler-Hammer Manufacturing Co., Milwaukee, Wis.
  - National Carbon Co., Clarksburg, W. Va.
  - Western Electric Co., Chicago, Ill.
  - Western Union Telegraph Co., New York, N. Y.
- Firearms:
  - Winchester Repeating Arms Co., New Haven, Conn.
- Furniture and fixtures:
  - American Furniture Co., Batesville, Ind.
  - Albert Pick & Co., Chicago, Ill.
  - American Seating Co., Grand Rapids, Mich.
  - Northfield Co., Sheboygan, Wis.
  - Tennessee Furniture Corp., Chattanooga, Tenn.
- General Supplies:
  - Carson, Pirie, Scott & Co., Chicago, Ill.
  - Montgomery Ward & Co., Chicago, Ill.
- Glassware: Illinois Glass Co., Alton, Ill.
- Groceries: Sprague, Warner & Co., Chicago, Ill.
- Hardware, foundry, and metal works:
  - Aluminum Company of America Pittsburgh, Pa.
  - American Car & Foundry Co., Milton, Pa.
  - Chase Metal Works, Waterbury, Conn.
  - E. & T. Fairbanks & Co., St. Johnsbury, Vt.
  - Fairbanks, Morse & Co., Indianapolis Ind.
  - Kohler Co., Kohler, Wis.
  - National Enameling & Stamping Co., Milwaukee, Wis.
  - Ohio Brass Co., Mansfield, Ohio.
  - Scoville Manufacturing Co., Waterbury, Conn.
  - Stanley Works, New Britain, Conn.
  - Hugh L. Thompson, Waterbury, Conn.
  - Whiting Corporation, Harvey, Ill.
- Instruments:
  - Brown & Sharpe Manufacturing Co., Providence, R. I.
  - Taylor Instrument Companies, Rochester, N. Y.
- Lighting supplies: Prest-O-Lite Co., Indianapolis, Ind.
- Lumber:
  - Russell J. Matthias Co., Chicago, Ill.
  - J. E. Morris Lumber Co., Seattle, Wash.
  - Western Pine Manufacturers Association, Portland, Oreg.
- Lumber—Continued.
  - Weyerhaeuser Forest Products, St. Paul, Minn.
- Machinery:
  - Burroughs Adding Machine Co., Detroit, Mich.
  - Challenge Machine Co., Grand Haven, Mich.
  - Mergenthaler Linotype Co., Brooklyn N. Y.
  - National Cash Register Co., Dayton, Ohio.
  - Oliver Chilled Plow Works, South Bend, Ind.
  - Patent Button Co., Waterbury, Conn.
  - United Shoe Machinery Corporation, Beverley, Mass.
  - United Shoe Machinery Corporation, Boston, Mass.
- Meat:
  - Armour & Co., Chicago, Ill.
  - Kingan & Co., Indianapolis, Ind.
  - Libby, McNeil & Libby, Chicago, Ill.
  - Morris & Co., Chicago, Ill.
  - Swift & Co., Chicago, Ill.
  - Wilson & Co., Chicago, Ill.
- Oil:
  - Texas Co., Port Arthur, Tex.
  - Texas Co., Hot Springs, Ark.
- Paper and paper products:
  - Hammermill Paper Co., Erie, Pa.
  - Marathon Paper Mills Co., Rothschild, Wis.
  - Western States Envelope Co., Milwaukee, Wis.
- Phonographs:
  - Brunswick-Balke-Collender Co., Muskegon, Mich.
  - Sonora Phonograph Co., Saginaw, Mich.
- Pineapples: Hawaiian Pineapple Co., Honolulu.
- Soap: Colgate & Co., Jersey City, N. J.
- Stoves:
  - Abram Cox Stove Co., Philadelphia, Pa.
  - Cribben & Sexton, Chicago, Ill.
  - Estate Stove Co., Hamilton, Ohio.
  - Richardson & Boynton, Dover, N. J.
- Tags: Dennison Manufacturing Co., Framingham, Mass.
- Transportation:
  - American Railway Express Co., Minneapolis, Minn.
  - Bureau of Expolsives, New York, N. Y.
  - E. S. Evans & Co., Detroit, Mich.
  - Union Transfer & Storage Co., Madison, Wis.
- United States Government:
  - Forest Service, San Francisco Calif.
  - Forest Service, Missoula, Mont.
  - Quartermasters Section, Chicago, Ill.

THE GLUING OF WOOD.

The demonstration course in the gluing of wood is planned for those in charge of gluing in shop or factory where any kind of glued wood product is manufactured. The course deals with fundamental principles underlying the advantages and uses of different kinds of glues, the preparation of the wood for gluing, and the operations involved in making glued joints.

Emphasis is placed on the precautions which can easily be observed in the care and use of glues and in the gluing conditions in order to improve the quality of the joints. All kinds of glues and all the more common woods used in glued construction are considered during the course.

Complete demonstrations are conducted to show the best methods of mixing and caring for the glue, the best gluing conditions and methods, and finally the tests which show the comparative value of the different processes. These demonstrations are supplemented by discussions of the suitability of different glues for various purposes. The practical nature of the course is increased by discussions of the special problems of the men attending the course, with suggestions for remedying their difficulties.

Expert wood technologists point out characteristics of different woods which make them suitable for various uses.

WHAT THE COURSE COVERS.

Study of various glues.—Sources of materials, methods of manufacture, characteristics, and properties of animal, vegetable, and water-resistant glues; meaning and importance of various tests of glues.

Animal glues.—Grades of animal glue; testing the quality of animal glue.

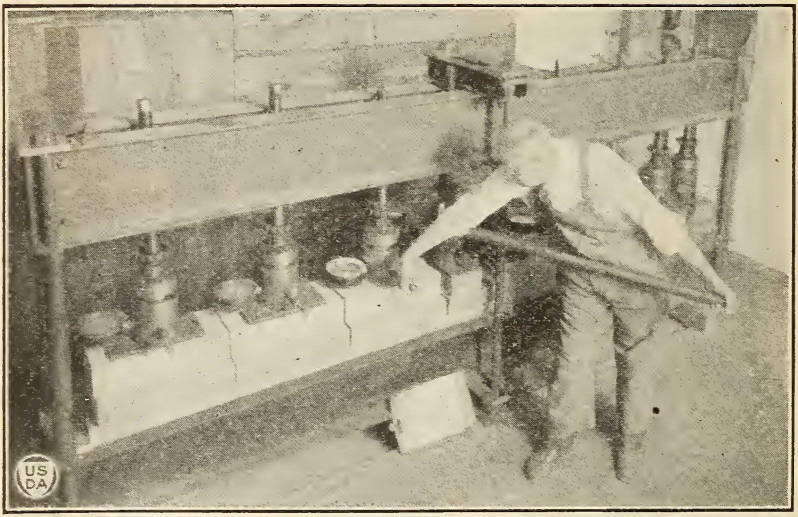
Vegetable glues.—Mixing and using vegetable glues; reducing the staining from vegetable glues.

Water-resistant glues.—Kinds of water-resistant glues; formulas; demonstration of mixing and using casein glues; reducing the staining from casein glues; demonstration of mixing and using blood albumin glues; cold-pressing blood albumin glues.

Rate of setting of various glues.—Rate at which different glues set and the strength of the joints increases; conditions which affect the rate of setting; relation of rate of setting to the pressure period in gluing and to advisable lapse of time before machining the joints.

Study of the wood to be glued.—This is of extreme importance in determining the best gluing practice.

Structure and composition of wood.—Kinds of cells in wood; advantages of wood because of cellular structure; how a tree grows; formation of annual rings; spring wood and summer wood; plain-sawed versus quarter-sawed lumber; heartwood versus sapwood; how texture of wood affects gluing; how glue penetrates wood; necessary conditions to secure adequate penetration; dangers of excessive penetration; relation of penetration and wood structure to strength of glued joints.



What is the proper pressure to use in gluing wood, and on what does it depend? This man is finding out.

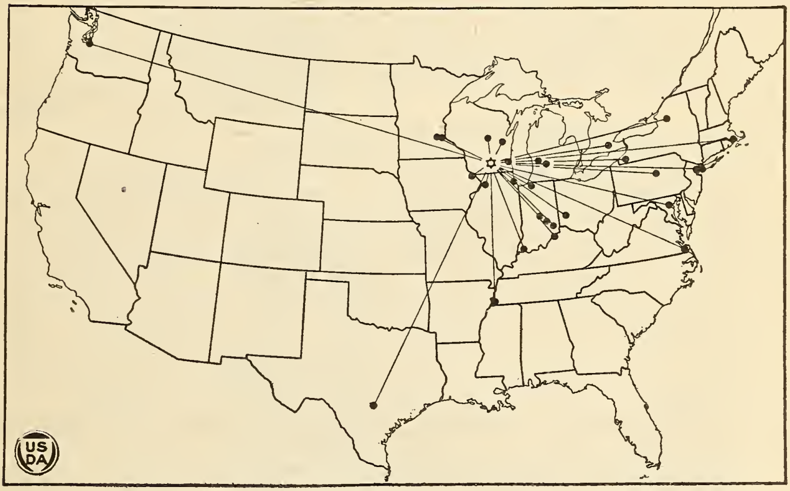
Moisture content of wood.—Meaning of "sap"; a simple means of accurately determining percentage of moisture in green, air-dry, and kiln-dry lumber; proper moisture content for gluing wood for various uses; amount of moisture added in gluing; effects of glue moisture; necessity for conditioning and drying glued products; variation of moisture in wood with changes in atmospheric humidity.

Shrinking and swelling of wood.—Cause of shrinking and swelling; how moisture content affects shrinkage; percentage of shrinkage of different woods; effect of density, of different methods of drying, and of other treatments on the shrinkage of woods; methods of reducing shrinking and swelling to a minimum.

Identification of woods.—Easy but positive means of identifying the more common species; structural characteristics and properties.

Seasoning of lumber.—Advantages and limitations of air seasoning; proper methods of piling; time required; defects resulting from air seasoning; advantages and limitations of kiln drying; methods commonly employed; necessity of properly regulating temperature and humidity in kilns; difficulties encountered in kiln drying; testing kiln-dried lumber.

Defects which may occur in seasoning lumber.—Cause of cupping, warping, and bowing and how these may be reduced; meaning and cause of casehardening; objections to using casehardened lumber; test for casehardening; how casehardening may be avoided or overcome; cause and prevention of honeycombing; cause and prevention of collapse.


Geographical distribution of firms represented at courses in the gluing of wood.

Preparation of wood for gluing.—Proper cutting of veneer; necessity of properly drying and conditioning lumber and veneer; care in planing and jointing; tooth-planed versus smooth surfaces; storage of machined parts before gluing.

Pressure, temperature, and assembly time in gluing.—Effect on quality of joint of variation in joining pressure, temperature of the room and wood, manner of assembling laminations or plies, time elasping between spreading the glue on the wood and pressing, and kind and amount of glue spread; control of gluing conditions; variation of gluing conditions for differences in woods; demonstration of gluing under different conditions.

Principles of glued wood construction.—Plywood and veneered panels; demonstration of comparative advantages of symmetrical and unsymmetrical construction; effect of gluing together plies of different species of wood, or of different moisture contents, or with the grain of the plies at different angles; laminated wood, its advantages and disadvantages; end grain joints.

Humidity control in factories.—Underlying principles; limitations; humidifying versus dehumidifying; systems in use; demonstration of experimental equipment and methods.

Moisture-resistant coatings for wood.—Effectiveness of different coatings for preventing moisture changes in wood and protecting glue joints; relative advantages of paints, oils, varnishes, shellac, etc., for this purpose; test of different types of coatings.

Defects common in gluing.—Face checks, blisters, sunken joints, overlaps, loose veneer, and weak joints; cause of; methods of preventing defects.

FIRMS WHICH HAVE BEEN REPRESENTED AT COURSES IN THE GLUING OF WOOD.

- Cabinets:
  - Bates Cabinet Co., Batesville, Ind.
  - Hardwood Products Co., Neenah, Wis.
- Chairs:
  - Grand Rapids Book Case & Chair Co., Hastings. Mich.
  - Grand Rapids Chair Co., Grand Rapids, Mich.
- Furniture:
  - Berkey & Gay Furniture Co., Grand Rapids, Mich.
  - Carrollton Furniture Manufacturing Co., Carrollton, Ky.
  - Davis-Birely Table Co., Shelbyville, Ind.
  - Haberer Furniture Co., Lowville, N. Y.
  - Joerns Bros. Furniture Co., Stevens Point, Wis.
  - Karges Furniture Co., Evansville, Ind.
  - O. A. Klamer Furniture Co., Evansville, Ind.
  - Kramer Manufacturing Co., Indianapolis, Ind.
  - Luger Furniture Co., North St. Paul, Minn.
  - The A. C. Norquist Co., Jamestown, N. Y.
  - Penn Furniture Manufacturing Co., Montgomery, Pa.
  - Reliable Furniture Manufacturing Co., Baltimore, Md.
  - John Widdicomb Co., Grand Rapids, Mich.
- Glue manufacturers:
  - American Glue Co., Chicago, Ill.
  - Canada Glue Co., (Ltd.), Brantford, Canada.
  - Casein Manufacturing Co., New York, N. Y.
  - Monite Waterproof Glue Co., Minneapolis, Minn.
  - Perkins Glue Co., South Bend, Ind.
  - United States Glue Co., Milwaukee, Wis.
- Individuals:
  - W. H. Negley, Madison, Wis.
  - Joseph Swoboda, Milwaukee, Wis.
- Instruments: Keuffel & Esser Co., Hoboken, N. J.
- Lighting supplies: Delco-Light Co., Dayton, Ohio.
- Mill supplies: Allen Co., New Bedford, Mass.
- Office equipment: Macey Co., Grand Rapids, Mich.
- Pianos: Steinway & Sons, Long Island City, N. Y.
- Refrigerators: Illinois Refrigerator Co., Morrison, Ill.
- Sash, doors, etc.;
  - Carr, Ryder & Adams Co., Dubuque, Iowa.
  - Steves Sash & Door Co., San Antonio, Tex.
  - Wheeler, Osgood Co., Tacoma. Wash.
  - J. G. Wilson Corporation, Norfolk, Va.
- Veneer: Nickey Bros., (Inc.), Memphis, Tenn.

WOOD PROPERTIES AND USES—A DEMONSTRATION COURSE FOR LUMBER SALESMEN.

This course is intended principally for those who sell lumber, whether wholesale or retail, but it is also of advantage to executives of sawmills and distributing agencies and to secretaries of associations.

The purpose of the course is to give the salesman information on the technical and economic aspects of lumber which will be of use to him in selling his product for the purpose for which it is best suited, and in giving his customers authoritative information on the best methods of handling and using the lumber they buy, thereby increasing the usefulness of each kind of wood and avoiding some of the embarrassments that result from unskilful merchandizing.

WHAT THE COURSE COVERS.

Structure and composition of wood.—Kinds of cells in wood; advantages of wood because of cellular structure; how a tree grows; formation of annual rings; spring wood and summer wood; plain-sawed versus quarter-sawed lumber; heartwood versus sapwood; how structure, color, and odor help in identifying wood; how knowledge of the structure of wood helps in understanding the properties and uses of wood.

Moisture content of wood.—Meaning of "sap"; a simple means of accurately determining percentage of moisture in green, air-dry, and kiln-dry lumber; proper moisture content for various uses; variation of moisture in wood with changes in atmospheric humidity; how to store lumber and manufactured wood products; relative advantages of paints, oils, varnish, shellac, etc., in retarding changes in moisture content of wood.

Shrinking and swelling of wood.—Cause of shrinking and swelling; relation of moisture content to amount of shrinkage; extent of shrinkage of different commercial woods; effect of density, of different methods of drying, and of other treatments on the shrinkage of woods.

Decay and durability of wood.—Cause of decay; how it spreads; seriousness of decay; methods of checking spread of decay; preservative treatment; how woods compare in natural durability.

Strength of wood.—Definition of common terms used by engineers; average strength values of commercial woods; variations in strength; factors affecting strength of wood, such as moisture, density, species, direction of annual rings, defects, size and shape of piece, etc.; factors of safety and safe working stresses for structural timbers; grading structural timbers for strength.

Seasoning of lumber.—Purposes of seasoning lumber; need for better practice; advantages and limitations of air seasoning and of kiln drying; proper methods of piling; time required for seasoning; necessity of properly regulating temperature and humidity in kilns; difficulties encountered in kiln drying; testing kiln-dried lumber.

Defects which may occur in seasoning lumber.—Cause of warping, cupping, and bowing, and how these may be reduced; meaning and cause of casehardening; objections to using casehardened lumber; test for casehardening; how casehardening may be avoided or overcome; cause and prevention of honeycombing; cause and prevention of collapse.

Gluing of wood.—Best practices in gluing wood; causes of gluing difficulties; relative advantages of different kinds of glues; plywood and laminated construction; possibilities in gluing together small pieces for large members; gluing properties of different woods.

Grading of lumber.—Purposes of grading; basis for grades; defects (standard); uses for different grades of lumber; variation in grading rules of different associations; comparison of grades of different kinds of lumber; advantages of grade standardization.

Timber resources.—Amount of standing timber; where located; movements of lumber industry; annual cut; imports and exports; consumption per capita; future of the lumber industry.

Lumber prices.—Fluctuations in prices; comparison with other commodities; factors influencing prices of lumber; trend of prices; possibilities of stabilization.

Uses of the principal kinds of woods.—Kinds used for different purposes; uses of species of wood in which class is interested; how new uses may be determined from thorough knowledge of properties of wood; uses of low-grade lumber, especially for boxes; market for small ready-cut dimension stock as possible solution of the low-grade and waste problems of the lumber industry; some advantages and disadvantages of wood over other structural materials.

FIRMS REPRESENTED AT FIRST COURSE IN WOOD PROPERTIES AND USES FOR LUMBER SALESMEN.

Bigelow-Cooper Co., Bay City, Mich.
C. C. Collins Lumber Co., Rhinelander, Wis.
Kneeland-Bigelow Co., Bay City, Mich.
Northern Hemlock & Hardwood Manufacturers Association, Oshkosh, Wis.
I. Stephenson Co. Trustees, Wells, Mich.
Von Platen-Fox Co., Iron Mountain, Mich.
Weyerhaeuser Sales Co., Waterloo, Iowa.
Weyerhaeuser Sales Co., Cleveland, Ohio.
Weyerhaeuser Sales Co., Detroit, Mich.
Weyerhaeuser Sales Co., Pittsburgh, Pa.
Weyerhaeuser Sales Co., Oshkosh, Wis.
C. H. Worcester Co., Chassel, Mich.

COST OF THE DEMONSTRATION COURSES.

The funds at the disposal of the laboratory are insufficient even for the most urgent problems of research; consequently a cooperative charge is made to cover the cost of these demonstration courses.

The cooperative charges for each man enrolled in each of the various courses is as follows:

Kiln drying (two weeks)	$150
Boxing and crating (one week)	100
Gluing of wood (one week)	100
Wood properties and uses (one week)	100

Payment may be made by postal or express money order or by national bank cashier's check drawn payable to "Federal Reserve Bank, Chicago, Ill." All payments should be sent to Fiscal Agent, Forest Products Laboratory, Madison, Wis.

DATES FOR FUTURE COURSES.

NOTE.—As each course is arranged to occupy the full time of the men attending it, no one will be enrolled in more than one course at a time.

Kiln drying .... {

Boxing and crating .... {

Gluing of wood .... {

Wood properties and uses .... {

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